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BY THE U.S. GENERAL ACCOUNTING OFFICE

Report To The Chairman, Subcommittee On Defense, Committee On Appropriations, House Of Representatives

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Factors Limiting The Availability Of F-15 Aircraft At The 1st Tactical Fighter Wing

The Air Force's 1st Tactical Fighter Wing has had difficulty in maintaining a high percentage of mission-capable F-15 aircraft, but has made significant recent improvements. Maintenance problems primarily included shortages and diversion of skilled personnel and the need to service more aircraft than authorized. GAO did not find significant defects in the Air Force supply system causing the absence of parts; instead, unpredictable circumstances relating to reliability, vendors, and modifications appeared largely responsible.

Because GAO work was limited to one Air Force wing and tests were not statistically sampled, the report is not an adequate basis to estimate conditions Air Force-wide. Therefore, GAO makes no recommendations. However, GAO believes the factors noted argue more for better management of unpredictable parts performance than for significantly increased funding.

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UNITED STATES GENERAL ACCOUNTING OFFICE
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PROCUREMENT, LOGISTICS,
AND READINESS DIVISION

B-207584

The Honorable Joseph P. Addabbo
Chairman, Subcommittee on Defense
Committee on Appropriations
House of Representatives

Dear Mr. Chairman:

In response to your June 15, 1981, request, we have reviewed the availability of the Air Force's F-15 aircraft assigned to the 1st Tactical Fighter Wing (TFW), Langley Air Force Base, Virginia. You asked us to identify and analyze factors affecting the peacetime readiness of aircraft at this Wing, such as shortage of maintenance personnel, problems in the supply system, imbalances in the type and number of aircraft spares available, and problems in the availability and effectiveness of automated test equipment.

Because our analysis focused on only one Air Force wing and because some of our tests were not statistically sampled, the information in this report does not provide an adequate basis to estimate conditions Air Force-wide. However, our analysis showed that the major problems affecting aircraft availability were maintenance and absence of parts. In the maintenance area, the study showed that:

--Although the number of assigned maintenance personnel at the 1st TFW slightly exceeded its authorization, there was a shortage of skilled, experienced people in certain key maintenance career fields because of Air Force-wide shortages in these skills.

--Some high paygrade enlisted personnel, assigned as maintenance supervisors, had no prior F-15 experience.

--Maintenance personnel service more aircraft than authorized during peacetime and many assigned aircraft mechanics were not working on direct aircraft maintenance because of leave, training, and temporary assignment to other jobs.

--Low availability of computerized test equipment and the placement of good components in the repair pipeline slowed component repair time and contributed to the shortage of parts.

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Regarding the absence of parts, we found no significant defects in the Air Force supply system or imbalances in aircraft spares available. Based on our test of 45 needed parts, we found that the parts were not available primarily due to unpredictable circumstances inherent in the supply system, such as lower than expected reliability of parts, problems with vendors, and modification of items. To a small degree, problems occurred within the Air Force logistics system.

These matters are discussed in detail in the enclosure. Our observations are that the Air Force is aware of and is working toward resolving the maintenance problems, and is actively pursuing or nas resolved the specific parts shortages identified in this report. Based on this and the limited scope of our analysis, we nave no specific recommendations.

As requested by your Office, we did not obtain written comments from the Air Force on the matters discussed in this report. We did discuss the contents with Air Force officials and they agreed with our findings. However, the officials expressed concern that the findings might be taken out of context to indicate that tne Air Force does not need increased funds for spare parts.

We are sending copies of this report to the Secretary of Defense and to the Secretary of the Air Force.

Sincerely yours,

Donald J. Horan

Donald J. Horan
Director

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APPENDIX I

FACTORS LIMITING THE AVAILABILITY OF F-15 AIRCRAFT AT THE 1ST TACTICAL FIGHTER WING

INTRODUCTION

The F-15 is the top air superiority fighter aircraft in the Air Force today. Costing over $20 million each, these air-to-air fighters are assigned both to forward bases overseas and to three operational wings within the United States. The 1st Tactical Fighter Wing (TFW), Langley Air Force Base, Virginia, was the Air Force's first operational F-15 aircraft wing, and in July 1981, was designated as part of the Nation's Rapid Deployment Force. The 1st TFW is organized into three operational squadrons with a total of 72 authorized F-15 aircraft.

OBJECTIVES, SCOPE, AND METHODOLOGY

At the request of the Chairman, Subcommittee on Defense, House Committee on Appropriations, we have reviewed the availability of the Air Force's F-15 aircraft assigned to the 1st TFW. Our objective was to identify and analyze those factors affecting the peacetime readiness of aircraft at this Wing, such as shortage of maintenance personnel, problems in the supply system, imbalances in the type and number of aircraft spares available, and problems in the availability and effectiveness of automated test equipment. We made our review in accordance with GAO's current "Standards for Audit of Governmental Organizations, Programs, Activities and Functions."

We performed work primarily at the 1st TFW, Langley Air Force Base, Virginia. We interviewed Wing managers; analyzed instructions, records, and documents; and examined several reports and studies. For the most part, this analysis focused on the 4-month period from June through September 1981.

During this period, we made several snapshot tests of the Wing's maintenance and supply conditions and practices. These tests usually involved the random selection of a limited number of parts, which the Wing was repairing, ordering, or sending back to the depot. For the parts selected, we determined whether the Wing's efforts to repair or secure the parts were performed efficiently and in accordance with established procedures.

To determine external (non-Wing) reasons for the lack of some parts, we also performed a limited parts analysis at several Air Force Air Logistics Centers. We identified 15 aircraft parts and 30 engine parts that had been in short supply at the 1st TFW from February through July 1981. We discussed these parts with the depot item managers to determine what caused the problem.

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We did not statistically select the parts nor did we verify the reasons provided by the item managers, so the results of this analysis should not be used for projection. As our analysis focused on only one Air Force wing, the information in this report does not provide an adequate basis to estimate conditions Air Force-wide. Furthermore, Air Force officials pointed out that an analysis of parts on an Air Force-wide scale and in more depth as to root causes would probably reveal other problems and, in particular, past funding shortfalls.

To follow up on some problems and to obtain a broader perspective on others, we also performed limited work at the Tactical Air Command at Langley Air Force Base, Virginia, and at Air Force Headquarters in Washington, D.C.

F-15 AVAILABILITY PROBLEMS AT THE 1st TFW

Although it has made significant improvements in this area, the 1st TFW historically has had difficulty in maintaining a high percentage of mission-capable aircraft. For example, during 1980, the Wing's mission-capable rate 1/ was only 43 percent, while its goal was 70 percent. 2/ Also, a 1980 report on a major readiness inspection at the Wing specifically commented on the large number of aircraft which were not mission capable.

The following table shows that the 1st TFW's mission capable rates from May through September 1981 have increased.

1st Tactical Fighter Wing
F-15 Mission Capable Rates

	May	June	July	Aug.	Sept.
	----------percent----------				
Mission capable	59	64	53	65	72
Not mission capable	41	36	47	35	28
Reasons not mission capable:					
Maintenance	15	16	24	17	13
Supply	17	15	17	15	14
Both supply and maintenance	9	5	6	3	1

1/The mission-capable rate is that percentage of a unit's aircraft which is capable of performing at least one of its assigned missions. This peacetime readiness indicator is calculated by subtracting from 100 the percentage of aircraft that are not mission capable due to maintenance or supply.

2/The mission-capable goal was changed to 62 percent in 1981.

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Although mission-capable rates are not a direct measurement of wartime readiness or capability, such rates provide managers information on the condition of the units and highlight problem areas. For example, when a unit is ordered to mobilize for war, the current mission-capable rate becomes the starting point for getting as many aircraft ready as possible. Thus, high peacetime mission-capable rates would at least indicate a potential for greater initial wartime readiness than would low rates. Low rates could also retard the pilot training program if too few aircraft were available to meet flight training requirements. Moreover, as maintenance and supply problems increase the number of grounded aircraft, Wing managers usually compensate by (1) using parts from war-reserve spares kits and (2) using good parts from grounded aircraft (cannibalizing). While such actions improve the overall mission-capable rate, use of war-reserve spares can decrease wartime readiness. In addition, extensive cannibalization wastes staffhours, has a negative impact on morale, and can cause additional maintenance problems.

The mission-capable rates in the table on page 2 would have been significantly lower if the Wing had not extensively cannibalized aircraft and removed parts from war-reserve spares kits. For example, on August 5, 1981, the Wing had supply requisitions in for 109 parts that limit F-15 mission capability. Theoretically, this large number of parts could have grounded most of the Wing's aircraft. But, by cannibalizing aircraft and thus consolidating the shortages, the Wing had only 22 of the 78 aircraft 1/ not mission capable due to a lack of parts.

The cannibalization goal for the Wing is no more than 10 for every 100 flights. During August 1981, however, the Wing performed about 34 cannibalizations for every 100 flights for a total of 454 cannibalizations. This consumed over 1,500 maintenance staffhours. During that time, we were told the Wing also withdrew 302 items from the war-reserve spares kits.

The table also shows that the Wing's mission-capable rates significantly improved from July to September 1981. There appear to be two primary reasons for this improvement. First, because the 1st TFW was designated part of the Nation's Rapid Deployment Force on July 1, 1981, its readiness began receiving increased emphasis and support priority.

Second, a new base-level supply concept was implemented on a test basis that August. This new concept, the Combat Oriented Supply Organization, allows the Wing to (1) obtain parts available on base more quickly, (2) use parts from the war-reserve spares kits with fewer restrictions, and (3) immediately requisition needed parts from the depot if base-level testing and repair

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1/As discussed on p. 6, the Wing usually had more aircraft assigned than the 72 authorized.

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cannot be performed on the broken parts within 24 hours. Although some negative impacts from the new concept may arise, such as reduced levels in war-reserve spares kits and inflated supply requisitioning, the Wing's mission-capable rate has improved. However, since the test was not yet complete at the time of our audit, we did not evaluate the merits of the new concept.

Air Force officials also believe that better management and improved morale at the Wing helped increase the mission-capable rate.

MAINTENANCE FACTORS REDUCING F-15 AVAILABILITY

As shown in the table on page 2, maintenance reasons accounted for about half of the 1st TFW's aircraft which were not mission capable. According to the Air Force, a wing can reduce the number of aircraft which are not mission capable due to maintenance if it has enough qualified, experienced people working directly on the aircraft. At the 1st TFW, we found that fewer than needed and less qualified and experienced people were working on aircraft maintenance because of Air Force-wide shortages in certain skills, Air Force personnel assignment policies, more aircraft requiring maintenance than planned, and peacetime leave, training, and other duties.

Shortages of qualified personnel assigned to aircraft maintenance

The Air Force considers its fully qualified and advanced skilled maintenance people to be the backbone of its maintenance capability. Since these people are the Air Force's key maintenance technicians and supervisors, shortages can have a significant effect on mission-capable rates, particularly when the shortages are in critical aircraft maintenance career fields.

At the time of our review, the 1st TFW had serious shortages of skilled, experienced people in certain key enlisted maintenance career fields, even though the number of maintenance personnel slightly exceeded its authorization. For example, in July 1981 the 1st TFW had 1,678 enlisted maintenance personnel assigned and 1,676 authorized. But, because of Air Force-wide shortages in many skills, several key maintenance shops had fewer and less qualified people assigned than authorized.

At the time of our review, the Air Force had only 760, or 62 percent, of the 1,219 fully qualified (level 5) fuel system mechanics it needed to service all its aircraft. Because this shortage was spread among many units, the 1st TFW was assigned only 14, or 74 percent, of the 19 mechanics it was authorized. Similarly, at the advanced skill level (level 7) for this same career field, the 1st TFW had only 50 percent of the mechanics authorized because the Air Force had only 82 percent of its needs.

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The table below highlights other skill level shortages in critical maintenance fields at the 1st TFW.

Maintenance skill area	Skill level	Percentage of people short Air Force-wide	1st TFW
Integrated avionics computerized test station (F-15)	fully qualified	6	28
	advanced skill	28	37
Integrated avionics manual test station	fully qualified	13	37
	advanced skill	25	43
Tactical aircraft maintenance (crew chief)	advanced skill	16	21
Aircraft electrical systems	advanced skill	32	50
Aircraft pneudraulic systems	advanced skill	21	30

The Air Force is trying to reduce such shortages of skilled maintenance personnel. For example, the Air Force has greatly increased reenlistment bonuses for selected skills, and for fiscal year 1982, it plans to give a greater percentage of enlisted promotions to the critically short skill areas. Other Air Force initiatives include (1) a program to retrain some personnel with nonshortage skills to fill the shortage positions, (2) a recruiting program for individuals with prior service, and (3) a program which allows selected people to continue active duty beyond normal mandatory retirement. The Air Force believes that these initiatives will greatly alleviate its skill and experience shortages over the next 3 years.

Some senior enlisted personnel lack prior F-15 experience

Assignment of high paygrade enlisted personnel who have no prior F-15 experience to the 1st TFW also affects the quality and experience level of personnel at the Wing. For example, an E-8 maintenance supervisor position was recently filled by an E-8 whose past experience was on the F-111. Although this supervisor had no prior F-15 experience, his new responsibilities included managing and supervising the maintenance work of 60 mechanics working on 24 F-15s. In another maintenance shop at the 1st TWF, six maintenance supervisors had no prior F-15 experience.

According to the Air Force, such assignments are sometimes necessary to prevent inequities in the number of overseas assignments and to provide its personnel some base-selection preferences.

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The Air Force is aware of the problems caused by such assignments and is considering a program which would provide some formal training for senior maintenance people assigned to a different weapon system for the first time.

Maintenance personnel must service more aircraft than the Wing is authorized

According to Air Force officials, maintenance personnel authorizations are based on the Wing having 72 assigned F-15s. However, during our review, the Wing usually had 78 F-15s requiring service because some depot-maintenance float aircraft 1/ were assigned to the Wing. In addition, Wing personnel must service visiting aircraft from other bases and occasionally assist depot personnel in aircraft modifications. For example, on August 5, 1981, four personnel from one of the Wing's three maintenance units were assigned to work on two transient F-15s, and another person was helping depot people modify an aircraft canopy.

Peacetime personnel practices reduce personnel available for direct maintenance

During peacetime the number of Wing personnel working on direct aircraft maintenance is normally reduced by people on leave, at training, or on temporary assignment to other jobs. To examine the extent of lost time at the 1st TFW, we looked at one of the Wing's three maintenance units responsible for 24 aircraft. This unit had only 183 (87 percent) of its 211 authorized direct maintenance personnel. On August 5, 1981, only 125 people (59 percent of the authorization) were present and available for direct aircraft maintenance work. Fifteen were on leave or temporary duty, 13 were at training, 6 were on base details, 16 were performing maintenance management or administrative functions, and 8 were unavailable for other reasons.

Similarly, on August 17, 1981, another Wing maintenance unit had only 72 percent of its assigned personnel (or 69 percent of those authorized) actually available for direct aircraft maintenance.

We were told that for the most part, this personnel problem is an inherent peacetime problem that would not exist during wartime.

SUPPLY FACTORS REDUCING F-15 AVAILABILITY

After personnel, the primary reason that 1st TFW aircraft are not mission capable is the lack of parts. Too frequently, the

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1/These aircraft are part of the depot-level repair pipeline.

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mechanics did not have the needed parts to repair grounded aircraft and broken components. As a result, the Wing's repair of certain components was slow and aircraft cannibalization increased. Parts were unavailable at the 1st TFW due to problems occurring at the Wing level and problems external to the Wing.

Lack of parts slowed repair of avionics components and increased aircraft cannibalization

From October 1980 through June 1981, 1st TFW mechanics could obtain immediately from the base supply only 66 percent of all parts requested. Base supply had 82 percent of those requested parts which it was authorized to carry.

In addition to increasing not mission-capable rates for aircraft, the lack of parts also affected the Wing's repair of avionics components. When avionics parts are unavailable, broken components are placed on a shelf while the needed parts are on order. We found that some of these components remained on the shelf for extended periods of time and occasionally were cannibalized to fix other components of the same type. For example, one $187,000 avionics component had been awaiting parts for 162 days at the time of our review. During August 1981 a daily average of 72 avionics components were awaiting parts.

The lack of parts also forced the 1st TFW to increase cannibalization of components from aircraft that were already not mission capable. As noted earlier, though this practice keeps some aircraft flying, excessive cannibalization wastes maintenance hours and can also lead to the creation of "hangar queens"--aircraft that have not flown for at least 21 days--which are also plundered for parts. For example, on August 5, 1981, the 1st TFW had eight F-15s which had not flown for at least 21 days. All but two of these aircraft had been cannibalized to provide parts for other aircraft. Consequently, 54 mission-essential parts were missing from these six hangar queens. One of these F-15s had not flown for 58 days and was missing 9 parts, while another had not flown for 39 days and was missing 16 parts.

Base-level problems affecting the supply of spare parts

At the base level, we found that low availability of computerized test equipment and the placement of good components in the repair pipeline aggravated the parts shortage. We found only minor problems in the Wing's management of its supply and repair operations, though our tests were hampered by poor management data. Further, our tests of imbalances in type and number of aircraft spares were inconclusive because specific imbalances must be viewed from an Air Force-wide perspective, whereas our work was limited to the Wing level.

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Low availability of computerized test equipment

F-15 avionics maintenance is completely dependent upon the successful operation of computerized automatic and manual test stations. These computerized test stations check broken "black boxes" to identify faulty subcomponents. The low availability of the 1st TFW's automatic and manual test stations slowed F-15 avionics repair time, creating large backlogs of broken components.

For example, from June to August 1981 the Wing's automatic test stations were available for use only 67 percent of the time. During July the automatic test stations operated only 47 percent of the time. Availability of the manual test stations ranged from 71 to 87 percent during the 3-month period. Since F-15 avionics components requiring maintenance at the Wing cannot be tested and repaired when test stations are inoperable, a large backlog of components awaiting maintenance developed during this time. The following table summarizes the extent of this backlog during June, July, and August 1981.

	June	July	August
Average number of components awaiting maintenance:			
Automatic test stations	28	55	43
Manual test stations	13	27	13
Highest number of components awaiting maintenance on 1 day:			
Automatic test stations	59	86	60
Manual test stations	31	46	37

The low availability of the 1st TFW's computerized test stations was caused primarily by a lack of parts to repair the test equipment and frequent loss of the stations' air-conditioning or electrical power. For example, one piece of equipment in the manual test station, which checks several F-15 components, was broken almost 50 percent of the time from June through September 1981 because repair parts were unavailable. Overall, the lack of repair parts caused the manual test stations to be less than fully available about 26 percent of the 4-month period.

Loss of air-conditioning, necessary to operate the equipment in a controlled environment, and occasionally the power supply also caused significant downtime for the 1st TFW's computerized test equipment. During July 1981 the Wing's automatic test stations

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were inoperable 18 percent of the time due to a loss of air-conditioning. In addition, one piece of automatic equipment was inoperable 29 percent of the time because of power supply problems.

Officials at the 1st TFW attributed both air-conditioning and power problems to antiquated facilities, 20-year-old air-conditioning and power units, and a general shortage of maintenance funding. However, we were told that plans have been made to correct most of the facility problems by summer 1982.

Good components placed in repair pipeline

Parts availability at the Wing is also hampered by the significant number of good avionics components which are placed in the test and repair cycle pipeline. Mechanics frequently remove aircraft components which they suspect are broken and send them to testing and repair. However, many components, when tested, are found to be in perfect working order.

In addition to using more labor hours, such instances needlessly tie up good components and can add to backlogs at test stations. During June 1981, 23 percent of the 193 components checked by the automatic test stations were found to be in working order. In July 25 percent of 257 components tested by automatic test stations and 23 percent of 201 components checked by manual stations were in working order.

Similarly, the Wing frequently sent components to the depot level for repair which, when tested, were found to be in working order. Although specific statistics on this problem were not readily available, we were told that about 25 percent of all such avionics components sent to the depots were operable.

Air Force and Wing officials attribute these problems to inexperienced personnel; onboard aircraft test equipment that does not always isolate a problem to only one component; and, in some cases, software incompatibility between test equipment at the Wing and the depots. We were told that the problems are being monitored closely as part of an effort to reduce the number of good components placed in a repair pipeline.

Effectiveness of Wing supply and repair cycle

We made several tests of the effectiveness of the Wing's supply and repair cycle organizations. Although our tests were hampered by inadequate and inaccurate records, the deficiencies we found had little or no effect on aircraft availability. Wing officials attributed much of the records problem to the changes associated with the new base-level supply concept (see p. 7) that was being tested at the time of our review. They stated that as

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familiarity is gained with the new system, the accuracy of the records should improve.

An examination of nine items reported as overdue from base-level repair showed that only three were actually overdue. None of these parts, however, were causing an aircraft to be grounded. Of the other six items, three had been repaired on time and one was a computer error. Because of poor records and the lack of accountability, we were unable to locate or determine the status of two items. In all, management data for seven of the nine items was in error.

A test of 12 critical items to determine whether the desired stock levels were being achieved through proper accounting and requisitioning procedures revealed no significant problems.

We selected 15 needed parts to analyze whether the Wing's administrative actions to replace the parts were timely. Aspects examined included time to verify whether parts were available on base, send defective parts to base repair, requisition replacement parts from depots, and deliver parts received to the flight line. We found that the Wing took 10 hours or less to verify replacement part availability and send defective parts to repair shops or to requisition the parts from depots if there was no local repair capability. All selected parts were delivered to the flight line within 2 hours of receipt. The timing of these actions did not adversely affect aircraft availability.

We tested seven items that were being shipped back to the depot for maintenance to determine whether parts were being shipped in a timely manner. We found that three of the sample items were shipped from 1 to 4 days after the 3-day standard time. The item delayed 4 days, a $29,000 radar unit, was delayed because the base had run out of foam rubber to pack the item.

External problems affecting parts supply

To determine the external reasons for the lack of parts, we identified all F-15 aircraft and engine parts that had accumulated at least 4,000 not mission-capable hours at the 1st TFW from February through July 1981.

In all, 45 parts were identified, including 15 F-15 aircraft and 30 F-15 engine parts. 1/ We discussed these parts with depot item managers to determine what caused the supply problem. Since

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1/The engine parts may not have grounded aircraft if spare engines were available. However, according to Air Force officials, the types of problems affecting engine parts availability would be similar to the problems which do ground aircraft.

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we did not verify the causes cited by the item managers, nor did we statistically select the parts, the results of the analysis does not provide an adequate basis to estimate conditions Air Force-wide. The table below summarizes the results of our analysis. Also, appendix II lists problems affecting the parts we reviewed. Appendix III shows the similar results of an October 1981 Air Force study of problems related to other selected F-15 parts.

Summary of Reasons Cited As Causing Parts Problems

Reason	Number of times reason cited as a problem (note a)	Percentage of times reason cited as a problem	Percentage of parts that included each reason as a problem
Reliability lower than expected	22	34	49
Vendor problem: Difficulty in obtaining raw materials	13	20	29
Insufficient capacity	4	6	9
Other (strikes, out of business, etc.)	2	3	4
Modification or redesign of item	7	11	16
In-house depot repair problem (note b)	6	9	13
Depot administrative or recordkeeping error	4	6	9
Item manager error in purchasing	2	3	4
Peacetime stocks placed in war reserve stocks	2	3	4
Other	3	5	7
Total	65	100	

a/Many of the 45 items had more than one reason cited as a contributing problem.

b/These problems include lack of repair capacity, shortage of subcomponent repair parts, poor repair quality, and transportation delays.

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As shown in the table, we found that low reliability and vendor-related problems caused most of the shortages of the parts. The remaining problems included a wide range, such as modification or redesign of items, in-house depot repair problems, and recordkeeping.

Lower than expected component reliability, cited in 49 percent of the parts reviewed, is an inherent problem with sophisticated, high-technology weapon systems, such as the F-15, which have not fully matured. The Air Force logistics system is designed to highlight those parts which begin to fail faster than expected so that managers can take action to correct the problem. Corrective action primarily consists of either accepting a higher failure rate than originally planned and then buying the additional spares required to support this higher failure rate, or redesigning the component so that the originally planned reliability can be achieved. However, since both of these actions, buying more and redesigning, require time, today's reliability problems usually cannot be solved in the short term. Further, when today's problems are finally solved, in all likelihood, different problem parts will have surfaced with lower than expected reliability. Thus, the cycle generally continues as a weapon system matures.

Vendor problems, cited in 42 percent of the parts reviewed, is another inherent problem facing logistics managers. As the Air Force logistics system identifies vendor-related problems which affect the supply of needed aircraft parts, managers attempt to solve or reduce the problems. But, in many cases, managers find that they can do little to correct the problem in the short term. For example, Air Force managers can do little in the short term to reduce shortages of raw materials needed to make parts or to increase output of a vendor whose capacity is already at its limit. As with reliability, most vendor problems associated with particular parts are eventually solved, but in the meantime, a new set of parts usually will have surfaced with vendor problems.

Modification or redesign of an item was cited as a cause of the shortage in 7 (16 percent) of the 45 parts we analyzed. This problem is closely related to the low reliability problem. As discussed above, when parts fail faster than expected, one remedy is to modify or redesign the part to obtain greater reliability. However, this action requires some parts to be removed from the normal repair pipeline while they are undergoing modification. Although this action is necessary to solve the problem in the long term, it can exacerbate the shortage of a particular part in the short term.

Other factors cited as contributing to the shortages of parts included in-house depot level repair problems and administrative and recordkeeping errors. While we do not condone the existence of such problems, we recognize that some problems and errors will occur in a logistics system as large and as

complex as the Air Force's. Also, it appears that such problems are addressed as they are identified.

In summary, we believe most of the factors cited as causing the parts shortages are inherent problems that face logistics managers as they attempt to support weapon systems in an economical and efficient manner. However, these problems are not predictable on specific parts. To greatly alleviate these problems would require the purchase of a vast amount of extra spare parts so that enough spares would be available while reliability, vendor, and other problems are being solved as they occur. However, even this potential solution would not help much in the short term and the cost would be prohibitive. The Air Force, at least to some degree, recognizes this and does not expect to have all of its aircraft mission capable all of the time. Thus, it appears that the solution to the parts shortages does not lie in buying more parts than the minimum amount required to support the mission-capable goals, but in identifying and then managing and solving individual problems as they occur. The Air Force logistics system is designed to do this.

While we did not evaluate the effectiveness of the Air Force system in handling these problems, our 1982 report to the Secretary of the Air Force, "More Credibility Needed in Air Force Requirements Determination Process" (PLRD-82-22, Jan. 7, 1982), disclosed overstatements and understatements in requirements computations for depot-level reparable items.

Air Force officials stated that our analysis and observations accurately displayed the type of day-to-day problems encountered in providing logistics support for new weapon systems. However, they expressed concern over an inference which might be drawn that the Air Force does not need increased funds for parts. In addition, they raised questions as to whether item managers with whom we asked about parts problems, would have sufficient visibility of overall funding austerity. They mentioned the lack of prior funding for sustainability, such as for war-reserve spares and other war-reserve materials. And, they suggested that had past funding not been so austere, problems identified in our analysis, such as vendors going out of business, capability problems, and others, might not exist.

The Air Force views on funding constraints may have merit. However, our analysis was limited and appropriately qualified. While more detailed analysis would be required to support or rebut the Air Force views, we believe the factors mentioned argue more for better management to address the unpredictable parts performance than they do for significantly increased funding.

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APPENDIX II

DESCRIPTION OF THE PROBLEMS AFFECTING THE 45 PARTS ANALYZED

Part and stock number	Problem
Converter programmer 1280-01-042-3952	Extensive modification of these items removed them from the repair pipeline.
Strap assembly 1560-01-070-5016	The contractor did not have sufficient capacity to meet requirements for both new production aircraft and replenishment spares.
Rudder actuator 1650-01-065-7768	The item was experiencing lower than expected reliability. Also, the vendor was giving priority to producing items for new aircraft rather than producing spares, the technical orders for repair were changed before new repair kits were available to the depot, and the depot lacked sufficient test stands due to the inability of the vendor to produce stands and parts for the stands.
Servocylinder 1650-01-105-5523	This item began failing faster than expected. At the same time, the production leadtime increased significantly and a modification program began.
Ejector regulator 1650-01-015-5017	Demand for this item unexpectedly jumped from 20 to about 50 per month. Also, the depot experienced a shortage of subcomponent repair parts needed to repair the item.
Pump 1660-01-035-9636	A subcomponent part unexpectedly began to fail. As a result, too few of these subcomponents were in the inventory to meet the demand.
Camera body 6710-01-020-0408	A harness assembly for the camera body originally coded reparable was found to be unreparable. Also, more items were failing than anticipated.

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Part and stock number	Problem
Limit switch 5930-01-038-3875	The manufacturer of this item did not renew its contract and there was difficulty in finding another suitable manufacturer.
Flared tube sleeve 4730-00-427-8692 PT	Records showed assets were available. However, the depot lost the assets and a special inventory failed to locate them.
Seal assemoly 2840-00-534-1824 PT	The item failure rate was greater than forecasted and the item manager had not bought enough assets to support the higher demand for this long leadtime item.
Liner assembly 2840-01-017-7757 PT	The item was experiencing a high failure rate and malfunction problems. Also the item contained cobalt, which the manufacturer could not get in a timely manner to support production of this item.
Liner augmenter 2840-01-060-7953 PT	Item manager records showed sufficient assets on hand. However, the depot could not find any assets in its inventory.
Turbine case assembly 2840-01-045-3879 PT	The item contains waspaloy (an alloy containing cobalt). The manufacturer could not get timely delivery of this material from suppliers and therefore had difficulty in meeting production schedules.
Exhaust nozzle 2915-01-035-0276 PT	Demand was higher than initially anticipated. Also, this was a long leadtime item (27 months).
Hydromechanical sensor 2915-01-081-9055 PT	Demand was higher than anticipated on this long leadtime item (25 months). The item manager had not bought sufficient assets initially to supply the actual demand.

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APPENDIX II

Part and stock number	Problem
Aerial recepticle 1680-00-138-3516	Technical order inspections of this item resulted in extensive condemnations. The item manager had not bought enough assets to cover the unpredicted high demand.
Arm assembly 2840-00-326-6062 PT	Premature failure of this item significantly increased demand. This was a long leadtime item (23 months). Also, due to a design deficiency, the item was undergoing a redesign/modification.
Lubricating tank assembly 2840-01-022-5422 PT	The depot and some field activities had misidentified some assets. Therefore, even though assets were available, the depot's records incorrectly showed that no assets were available.
Support arm 2840-00-365-2026 PT	The item experienced a design deficiency resulting in premature failures with demands increasing from 61 to about 364 per year. The item was undergoing modification to fix the problem. Thus, there had been only limited procurement of the old item.
Exhaust bracket 2840-01-056-2695 PT	The item experienced premature failure and a significant increase in demand. Also, the item contains titanium, which was in short supply and lengthened production leadtime.
Straight pin 5315-01-003-9653	A design deficiency caused a high failure rate. The item was modified and production of a new item was affected by difficulty in getting material for the modified item.

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Part and stock number	Problem
Augmentor bracket 2840-00-331-5602 PT	The item contains cobalt, which the manufacturer had difficulty obtaining in needed quantities to meet production schedules.
Plain bearing 3120-00-344-1501 PT	The item contains an alloy, which the manufacturer was having difficulty obtaining. Also, the failure rate for this item was higher than predicted.
Assembly bracket 2840-01-035-0598	The item experienced premature failure, which increased demand. Also, the item contains waspaloy, which the manufacturer had difficulty obtaining. Thus, delivery schedules were delayed.
Interconnecting bracket 2840-00-340-7556 PT	Premature failure of the item resulted in a demand increase from 210 to 435 per year. The item also contains waspaloy which the manufacturer had difficulty obtaining. This difficulty affected production schedules, pushing leadtime from 9 to 26 months.
Retaining plate 3110-00-367-9674 PT	Premature failure increased this item's annual demand from about 94 to 720. The item was being redesigned to increase its useful life.
Cooler assembly 2935-00-361-6513 PT	The sole-source supplier had a labor strike.
Recorder 6680-01-041-9345 PT	Commands moved assets bought for peacetime operating stocks into war-reserve material accounts, thereby causing a shortage of this item in peacetime stocks. The war-reserve account had not been funded.
Fuel control 2915-01-016-7217 PT	The item manager decided not to buy an old configuration of the item due to a pending engineering change to the item.

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Part and stock number	Problem
Ball bearing 3110-00-356-5723 PT	The contractor had problems maintaining production due to difficulty in obtaining some materials, such as cobalt.
Rod end clevis 5340-00-395-7348 PT	The item contains titanium, which the contractor could not get in a timely manner. Further, increased quantities were failing.
Compressor shaft 2840-00-523-2036	Item manager records showed assets on hand. However, a depot inventory showed no assets available.
Carrier assembly 2835-01-003-8996	Depot overhaul condemnation rate increased unexpectedly to 95%. The item manager had not bought enough assets to support this high condemnation rate.
Machine bolt 5306-00-369-5848 PT	The item contains titanium. The manufacturer could not get timely supplies of titanium to maintain the production schedule.
Thermocoupler 6685-00-371-2162 PT	The item failed to operate as designed. Increased failure led to an engineering change with a resulting delay in designing and getting the new part.
Gas turbine engine 2835-01-034-4772	The item had been engineered for 700 hours mean time between failure. However, the item was getting only about 434 hours between failures. Also some support repair parts were not available due to problems in obtaining forgings.
Liner assembly 2840-01-008-0563 PT	The item began experiencing "burn through." Initially, the Air Force did not have drawings and could not buy needed patch materials. Drawings were bought and repair capability was designed to fix the item. However, burn throughs were still occurring.

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Part and stock number	Problem
Nozzle segment 2840-00-327-5474 PT	The item contains waspaloy, a high temperature alloy of cobalt, which the contractor had trouble getting from a supplier.
Accessory gearbox 2835-01-034-6948	The mean time between failure forecast for this item was 700 hours. However, the item began failing around 334 hours. This accelerated demand. Further, 56 percent of the repaired items failed to pass final tests and had to be reworked by the depot.
Engine control 2915-01-052-5314 PT	The depot did not have enough test stands to process the required volume of repaired items. As a result, repaired items backed up, pending final testing. The required number of test stands were not purchased due to a lack of funds.
Engine pump 2915-00-504-3043 PT	Initially, there was no repair procedure for this item when it began to fail. Reparable assets were stored pending development of a procedure. A repair procedure was later developed, but the depot was slow in sending the assets from storage to repair.
Actuator 1680-00-538-8968	The using commands placed peacetime operating stock assets in war reserve material accounts, thereby creating a shortage of this item in peacetime stocks. The war-reserve material account had not been funded.
Evaluator reply 5895-01-016-2209	Because the depot repair station for this item had been overloaded with higher priority repair requirements, repair of this item was slow. Also, there were administrative problems in purchasing needed new items.

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Part and stock number	Problem
Gearbox bracket 2840-00-335-0513 PT	The item contains cobalt, which the manufacturer had difficulties obtaining in the needed quantity to meet production schedules.
Assembly arm 2840-00-337-4341 PT	Premature failure of this item significantly increased demand. This was a long leadtime item (23 months). Also, due to a design deficiency, the item was undergoing redesign/modification.

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SUMMARY OF REASONS CITED AS CAUSING PROBLEMS IN AIR FORCE STUDY OF 20 F-15 PARTS IN SHORT SUPPLY

In October 1981 the F-15 system manager completed a study of problems causing shortages of 20 selected F-15 parts. The results of this study were somewhat similar to our analysis in that vendor part modifications and depot repair problems were cited as causes for the shortages. The Air Force study also found that shortages of component repair parts and limited capacity of depot-level test equipment affected the availability of the parts analyzed. The results of the Air Force study are shown below.

Reason category	Number of times reason cited as a problem (note a)	Percentage of times reason cited as a problem	Percentage of parts that included each reason as a problem
Shortage of component repair parts	10	38	50
Depot test station problem or lack of sufficient capacity	7	27	35
Modification of item or assets placed in war-reserve stocks	3	12	15
Extended vendor leadtime	2	8	10
Other	4	15	20
Total	26	100	

a/Some of the 20 items had more than one reason cited as a contributing problem.

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